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(54) A PARALLEL MOTION SYSTEM FOR A BUCKET OR THE LIKE IN LOADING MACHINES, POWER SHOVELS OR THE LIKE

(71) I, STEN OVE HAMMARSTRAND, a Swedish Subject of Fiskebyvägen 14, 824 00 Hudiksvall, Sweden, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a parallel motion arrangement for a bucket or the like mounted on a lifting arm in a mechanical excavator, power shovel or similar machine.

For universal utilization, the bucket or corresponding implement in mechanical excavators, power shovels or similar loading machines must be brought by manual or automatic manoeuvring into different desired attitudes in relation to the ground and the lifting arm on which the bucket is mounted. In loading, for example, the bucket must be driven into a pile of material possibly while carrying out a certain rocking movement to facilitate filling material in the bucket, and thereafter lift it up to a suitable height often in combination with travel or swinging for dumping in some other place or onto a load carrying vehicle.

While raising the bucket it is often desirable that it is given a parallel motion in relation to the ground. If the bucket is, for example, full to the top with material some of it may fall off if the bucket tips over in one direction or the other as it follows the lifting arm movement while being raised.

The problem of parallel motion of the bucket in relation to the ground can be solved manually by the operator observing the position of the bucket the whole time, and adjusting by hand the control means which via such means as hydraulic cylinders alter the angular attitude of the bucket. There are also several known solutions of the problem of automatic maintenance of bucket attitude such that it retains position in relation to the ground irrespective of the position of the lifting arm.

The present invention relates to a parallel motion system which has several advantages in relation to existing devices.

According to the invention there is provided a parallel motion arrangement for controlling the attitude of a bucket or the like mounted on a lifting arm in a mechanical excavator, power shovel or similar machine, comprising means for sensing the angular attitude of the bucket relative to the lifting arm, actuator means for altering the attitude of the bucket relative to the lifting arm, and control means operated by said sensing means for controlling the actuator means to successively alter the angular attitude of the bucket in response to the lifting position of the lifting arm, transmission means coupled to the sensing means and arresting means associated with the control means for optional co-action with said transmission means in relative mutual positions for operating the control means to control the bucket so that it automatically retains a predetermined angular attitude in relation to a ground configuration, the control means comprising a slide valve which on being operated by means of the co-action of the arresting means with the transmission means directs fluid to the actuator means for regulating the angular attitude of the bucket, and said slide valve being mechanically linked with a three-way valve whereby at extreme operation of said valves the three-way valve is caused to re-direct the fluid flow so that fluid from the outlet side of a working cylinder for operating the lifting arm is transferred as additional fluid to the actuator means for the bucket for its re-adjustment during rapid lowering of the lifting arm.

The invention is based on a method known *per se* for mechanically sensing the variations in the angular attitude of the bucket, in respective relation to the lifting arm and the loading machine chassis, which occur when the lifting arm is raised or lowered. Alterations in the angular attitude are transmitted to a control valve means which according to the movement of the lifting arm automatically corrects the angular

attitude of the bucket via hydraulic means so that it is given a parallel motion the whole time. An important characterizing feature is that the valve means is further provided with an automatically operating valve which comes into action on rapid lowering movement of the lifting arm, during which there are certain risks that the capacity of the hydraulic system is insufficient. Return fluid from the lifting arm hydraulic cylinder is then automatically led over to the hydraulic cylinder of the bucket through the last-mentioned valve and contributes to the operation of the bucket hydraulic cylinder. The valve means can be manually coupled to the mechanical sensing means for the bucket attitude in optional positions. This means that the bucket can be "locked" for parallel motion in separate positions, in turn signifying considerable advantages in all kinds of loading and unloading operations. The valve means is further preferably so arranged that the enabling of the manual coupling to the mechanical sensing means is limited to embrace an area within which the bucket can be angularly displaced in relation to the lifting arm without mechanically colliding with it.

The above and other features of the invention will be further pointed out in the following description of a preferred embodiment of the invention, reference being made to the accompanying drawings, in which:—

Figure 1 is a side view of a front loading mechanical excavator with a lifting arm and bucket, and a schematically denoted parallel motion system for the bucket according to the invention;

Figure 2 schematically shows the lifting arm and bucket according to Figure 1 with associated hydraulic means and linkage system for attitude adjustment, a sensing device with valve means according to the invention and a circuit diagram of the hydraulic lines.

Figures 3, 4 and 5 are schematic views similar to Figure 2 but showing different operative positions of the parallel motion system, hydraulic lines carrying fluid under pressure in use being denoted by full lines and lines carrying unpressurized fluid being denoted by dashed lines.

Figure 6 is a fragmentary detail view showing the sensing device in which position it does not co-act with the valve means;

Figure 7 shows the lifting arm of Figures 2 to 6 with an alternative design of the cable associated with the sensing device and respective springing means, and

Figure 8 in conjunction with Figures 2 to 6 shows an alternative design of the valve means and an intermediate position means co-acting with it.

In Figure 1 there is shown a front loading mechanical excavator generally designed 1, provided with a raisable and lowerable lifting arm 2 which is arranged to pivot about a pivot point 4 rigidly attached to a chassis 3 of the machine 1. A pressure cylinder 5 operating between a pivot point 6 rigidly arranged on the chassis 3 and a pivot point 7 on the arm 2 is responsible in a known way for the upward and downward movement of the lifting arm 2 as represented by the double arrow P1.

A bucket 9, tippable according to the double arrow P2, is arranged about a pivot point 8 at the outer end of the excavating arm 2. The tipping movement for the bucket 9 is provided by a pressure cylinder 10 the piston rod 11 of which, acting through a bifurcated lever 12, a linkage bar 13 and a pivot point 14, adjusts the bucket 9 to different angular attitudes in relation to the lifting arm 2 and thereby also to a ground configuration 15. It will be noted that the linkage system between the pressure cylinder 10 and the bucket 9 is so made that an outward thrust of the piston rod 11 causes tipping of the bucket 9 upwardly in Figure 1. A portion of the own weight of the bucket and the load possibly in the bucket is thus carried by a compression force on the piston rod 11. Figure 1 is a side view, and it should be added for the sake of clarity that as a rule the lifting arm 2 comprises two parallel arms, which embrace the chassis 3 on each side. The pivot points 4 and 8 are therefore in practice double. In conjunction with such a construction there are also two pressure cylinders 5, each with their pivots 6 and 7, one on either side, for adjusting the lifting arm 2. On the other hand, for adjusting the bucket 9 there is as a rule only one pressure cylinder 10 with associated linkage system 12, 13.

In conjunction with the pivots 4, 8 and coaxially with them, there are arranged in the embodiment shown two discs or wheels 16 and 17 which in the case shown are made as cable pulleys. The cable pulleys 16 run freely on the pivots 4, whereas the cable pulleys 17 are rigidly connected to the bucket 9 so that they turn synchronously with the bucket according to the double arrow P2. The cable pulleys 16 and 17 have the same diameter. With a somewhat angularly shaped lifting arm 2 of the type shown in Figure 1 there is a third cable pulley 18 on the lifting arm 2 which functions as a snubbing pulley in a suitable position (which is not operationally decisive) between the associated cable pulleys 16 and 17.

A cable 19 is partly wound up on the cable pulley 17, and runs over the cable pulleys 18, 16 and has its free end 19^1 connected to a valve system and only schematically denoted by chain dotted lines 20 in Figure 1.

The pressure cylinders 5, 10 and the valve system 20 are connected to each other and to

manually operable control means 22 in a driving cabin 21 of the machine 1 by means of hydraulic pressure lines which are flexible to a suitable degree, and which are not shown in Figure 1 but are clearly seen from Figures 2 to 5, in which the embodiment of the valve means 20 is more closely although schematically set forth. In Figure 2 there is generally and schematically shown, and in appropriate cases with conventional symbols for incorporated standard components, the parallel motion system according to the invention, the same reference numerals as in Figure 1 being used for corresponding parts. The system is supplied with a pressure fluid, e.g. hydraulic oil, which is taken from a fluid tank 23 by means of a pressure fluid pump 24 via filter 25 and a pressure regulating by-pass valve 26 through two lines 27 and 28 having non-return valves 29 and 30 to two manually adjustable four-way valves 31 and 32. Lines 33, 34 and 35 are arranged to take return fluid from these valves to the tank 23. The four-way valve 31 is arranged for manual control of the lifting arm 2, and is connected by lines 36 and 37 to the valve means 20, whence lines 38 and 39 go to the pressure cylinder 5. The four-way valve 32 is arranged for manual angular attitude control of the bucket 9 according to the double arrow P2, and is directly connected by lines 40 and 41 to the pressure cylinder 10. From the lines 40 and 41 branch lines 42, 43, 44 go to the valve means 20.

In the line circuit diagram according to Figure 2 there is also a line 28 which is connected after the filter 25 and passes through the four-way valves 31, 32, whereafter it is connected to the lines 34, 35 going to the tank 23. The line 28^1 denotes in principle that the pressure fluid pump 24 is conventionally depressuprized when the four-way valves 31, 32 are in the intermediate position, i.e. when no pressure fluid or return fluid communication takes place through them. As soon as either of the four-way valves 31, 32 is brought into action for an operation the line 28^1 is automatically closed.

The valve means 20 comprises a four-way slide valve 45 and a three-way valve 47 mechanically connected by a connecting bar 46. The combined action of the valves 45 and 47 is such that when they are moved downwards from their position shown in Fig. 2 the valve 45 will open connections between the line 36 and the line 43 as well as between the line 39 and the line 42. The valve 47 will maintain the connection shown between the lines 37 and 38. This remains the case even in the end position of the valves in the direction in question. When the valves are moved upwards the valve 45 provides the same connections and the valve 47 still connects the lines 37 and 38. However, excessive upward movement of the said valves will cause the valve 47 to switch over so as to connect the line 38 with the line 44. During such an excessive actuation of the valves the connections opened by the valve 45 are still maintained. Thus the valve 47 switches only on excessive movement of the said slides in an upward direction.

From the slide valve 45 projects a rod 48 with an intermediate position means consisting of a housing 49 attached to the chassis 3, with two opposed action-compression springs 50, 51 and an intermediate washer 52 rigidly connected to the rod 48. The intermediate positioning means generally designated 53 tends automatically to maintain the slide valve 45 in an intermediate position, the significance of which will be dealt with later.

At the upper end of the rod 48 in Fig. 2 there is arranged an arresting means 54 with a locking pin 55 which tapers at one end and is transversely positioned in relation to the rod 48 and is displaceable according to the double arrow P3. Displacement is provided manually by a push-button 56 or similar device and the operating impulse is transmitted electrically via a lead 57 or mechanically via a Bowden cable.

The arresting means 54 is arranged in conjunction with a transmission bar 58 which is mounted for longitudinal displacement according to the double arrow P4 and which at the lower end in Figure 2 is connected to a tension spring 59 fixed to the chassis 3. At the upper end of the transmission bar 58 the previously mentioned end 19^1 of the cable 19 is rigidly affixed. It is apparent from Figure 2 that tipping the bucket 9 in an upward direction without altering the position of the lifting arm 2 causes an automatic movement of the transmission bar 58 in the downward direction. It is also clear that lifting the lifting arm 2 without altering the mutual disposition of the bucket 9 and the lifting arm causes a corresponding movement of the transmission bar 58. The position of it is therefore indicative of both the position of the lifting arm 2 to the ground configuration 15 and for the relative angular relationship between the bucket 9 and the lifting arm 2.

On a side of the transmission bar 58 directed towards the arresting means 54 there is arranged a restricted toothed portion 60, the extension of which corresponds to a predetermined movement of the transmission bar 58 by positional adjustment of the lifting arm 2 and the bucket 9. By displacement of the locking pin 55 under the actuation of impulses from the push-button 56 the locking pin 55 and the toothed portion 60 can be brought to co-act so that the arresting means and thereby the rod 48 and the

slide valves 45 and 47 follow the upward and downward travel of the transmission bar 58. Such an arresting position is shown in Figure 2. On the other hand, the arresting means 54 can be completely released from the transmission bar 58 by the locking pin 55 being moved to the right in Figure 2 on a releasing impulse from the push-button 56. Such a position is shown in Figure 3. The arresting means 54, and similarly the slide valve 45, then adjusts itself to the previously mentioned intermediate position and remains in it without being affected by possible movements of the transmission bar 58. By means of the toothed portion 60 the locking pin 55 can be arrested in an optional position within the toothed area with advantages which will be more closely dealt with in the following.

The previously mentioned lines 36, 37 from the four-way valve 31 are connected to the four-way slide valve 45 and the three-way valve 47 as denoted in Figure 2. Lines 42 and 43 branch off the lines 40 and 41 going from the four-way valve 32 and are connected to the four-way valve 45. A branch line 44 from line 43 being connected to the three-way valve 47 and includes a return valve 44^1. Figure 2 also shows how the lines 38 and 39 to the pressure cylinder 5 are connected to the three-way valve 47 and the four-way slide valve 45, respectively.

For a first operation in the state shown in Figure 3, the described system enables optional adjustment of the lifting arm 2 by manual operation of the four-way valve 31 and simultaneously, irrespective of the position of the lifting arm 2, optional adjustment of the angular attitude of the bucket 9 in relation to the lifting arm 2 by manual operation of the four-way valve 32. As apparent from Figure 3 in this case the locking pin 55 is withdrawn in the arresting means 54, whereas the latter as well as the slide valves 45 and 47 are by virtue of the intermediate positioning means 53 in an intermediate position in which the line 39 from the pressure cylinder 5 communicates via the four-way slide valve 45 with the line 36 between the four-way valve 31 and the four-way slide valve 45 simultaneously as the line 38 to the pressure cylinder 5 via the three-way valve 47 communicates with the line 37 to the four-way valve 31. All said lines as well as the lines 40, 41 to the pressure cylinder 10 and the connecting lines 27, 28, 33, 34 to the four-way valves 31, 32 are denoted in Figure 3 with full lines while the branch lines 42, 43, 44 to the four-way slide valve 45 and the three-way valve 47 are dashed. The latter indicates that in the operational state according to Figure 3 they are blocked by the last-mentioned valves and thus do not carry pressure fluid.

The function of the system in this state is clear from Figure 3. The pressure cylinder 5 for adjusting the lifting arm 2 communicates solely with the four-way valve 31 and pressure fluid can be supplied or removed via it from the pressure cylinder 5 according to the double arrows P4, P5, for raising or lowering the lifting arm 2. Completely independent of the position of this valve, pressure fluid can be supplied or removed from the pressure cylinder 10 via the four-way valve 32 and the lines 40, 41 according to the double arrows P6, P7. Return fluid from both pressure cylinders 5, 10 is returned to the tank 3 via the lines 33, 34, 35 according to the arrow P8. It is also apparent from Figure 3 that the transmission bar 58 can move freely upwardly and downwardly in this state, without any co-action with the arresting means 54 and that there is no automatic parallel movement of the bucket 9. The described operational state occurs normally alternating with parallel motion of the bucket. This section of the description has therefore clearly shown one of the advantages at the invention, i.e. that by using a simple manual action it is possible to choose between parallel motion of the bucket line and optional adjustment of it through the four-way valve 32, independent of what position the lifting arm 2 is in.

In Figure 4 is shown an operational state of lifting arm 2 while giving parallel motion to the bucket 9. Similarly to Figure 3, fluid lines not used are denoted with dashed lines. The diagram is otherwise in agreement with Figure 3. By an impulse from the press-button 56, the locking pin 55 on the arresting means 54 is engaged with the toothed portion 60 on the transmission bar 58, which means that the four-way slide valve 45 reacts to the movements of the transmission bar 58, i.e. for the relative angular relationship of the bucket to the lifting arm 2 and of the lifting arm relative to the ground.

In this case only the four-way valve 31 is operated manually, pressure fluid passing through the lines 37, 38 via the three-way valve 47 to the pressure cylinder 5 according to the arrows P9. The elevation of the lifting arm caused thereby results in lowering the transmission bar 58, in turn resulting in connection between the line 39 from the pressure cylinder 5 and the branch line 42, and a corresponding connection between the line 36 to the four-way valve 31 and the branch line 43.

As is clearly shown in Figure 4, return fluid from the pressure cylinder 5 will then pass according to the arrows P10 to a pressure chamber 61 in the pressure cylinder 10, meaning that the bucket 9 will tip over according to the arrow P11. Return fluid from the pressure cylinder 10 recirculates at the same time to the tank 23 according to the arrow P12 via the lines 41, 43, 36, 33, 35,

the four-way slide valve 45 and the four-way valve 31.

If elevation of the lifting arm 2 takes place smoothly, continuous tipping of the bucket 9 according to the arrow P11 pro rata to the elevation is accomplished. Tipping pro rata to the elevation is accomplished due to the fact that the cable 19 moves the means 58 and connected members downward and thus the valve 45 moves to a position in which a connection as described above is obtained. The tilting attitude of the bucket 9 thus is changed relatively to the lifting arm 2 so as to keep the attitude of the bucket constant relatively to the ground. As soon as the movement of the arm 2 is terminated the bucket continues to turn the small distance until the cable 19 and connected members have actuated the valve 45 to a position for cut-off of the connections between the lines 36 and 43 and the lines 39 and 42 so that the bucket 9 remains in a stable attitude in relation to the lifting arm 2. As soon as the latter once again begins to rise, a re-adjustment in accordance with Figure 4 takes place once again. In this way the bucket 9 always maintains an unaltered angular attitude in relation to the configuration 15.

An analogous situation arises when lowering the lifting arm 2, Figure 5, although in reverse in relation to the fluid flow directions. When the lifting arm 2 is lowered, the transmission bar 58 will be pulled upwards by the cable 19 which in its turn causes the four-way slide valve 45 to be reset. On lowering the lifting arm 2 pressure fluid is led from the four-way valve 31 according to the arrow P14 via the line 36, the four-way valve 45 and the branch line 43 through the line 41 to the cylinder 10, at the same time as return fluid is recirculated to the tank 23 from the cylinder 5 and the line 38 via the valve 47 which for the moment is not changed (path indicated by dashes) and the line 37, according to the arrows P15. Return fluid furthermore returns from the pressure cylinder 10, according to the arrows P16, via the line 40 the branch line 42 for the four-way valve 45 and the line 39 to the cylinder 5. Because of the continuous sensing of the angular attitude of the bucket 9 through cable 19 and connected members the bucket will be rotated under equivalent conditions as when raising the arm 2, whereby the angular attitude of the bucket will be continually corrected so that its parallel attitude in relation to the ground configuration 15 is retained.

On a very rapid lowering of the lifting arm 2 conditions can arise such that the amount of fluid supplied from the pump is insufficient for maintaining parallel motion of the bucket. The slide in the three-way valve 47 will hereby move further upwards, together with the slide in the valve 45. This means that the function of the valve 45 remains, but that the valve 47 is caused to reverse, see the position in full lines in Figure 5, so that the line 33 is in communication with the line 44. In this way fluid will be transferred from the cylinder 5 via the line 38, the three-way valve 47, and the lines 44, 41 to the cylinder 10, further to the fluid coming from the pump through, *inter alia*, the line 43, whereby maintenance of the bucket parallel motion is automatically ensured.

It is clear that the locking pin 55 in the arresting means 54 can be moved into a locking position anywhere along the toothed portion 60 on the transmission bar 58. This means that a position giving parallel motion to the bucket 9 can optionally be pre-set for every angular attitude in relation to the lifting arm 2 which corresponds to the length of the toothed portion 60. As have been previously mentioned, portion 60 has a predetermined length shown as S1 in Figure 6, which implies a protective measure in the cases where the bucket 9 is manually, by means of the four-way valve 32, taken so near to the lifting arm 22, either upwardly or downwardly, that there is a risk of collision between the bucket 9 and the lifting arm 2 on continued movement under parallel motion of the bucket. In such a position, if the locking pin 55 is moved in towards the transmission bar 58 it will strike a non-toothed portion S2 or S3, whereat no arresting effect will be obtained. Only when the transmission bar 58 has first been moved sufficiently for the tapered end of the locking pin 55 to snap over the first tooth on the toothed portion 60 can arresting take place, and thereby an automatic parallel motion of the bucket 9 also.

Figure 7 shows in conjunction with Figures 2 to 5 an advantageous modification comprising a supplementary device to the cable 19, and a device which can alternatively replace the tension spring 59 which, in co-action with the transmission bar 58, keeps the cable tensioned. The supplementary device consists of an expandable means, e.g. a tension spring 62, which is arranged on the cable 19 and constitutes a part of this for a length which substantially corresponds to the length of the spring. There is furthermore arranged on the lifting arm 2 fixed stop 63 with an opening 64, the centre of which lies in line with the cable 19. On the latter there is a movable stop 65 which can adjustably be fixed rigidly to the cable to move with the cable and which cannot pass through the opening 64. The last-mentioned means are so placed in relation to each other that the following function occurs when the lifting arm is elevated and the bucket 9 is given parallel motion. In this position if the bucket is manually tipped via the four-way

valve 32 for emptying, the stop 65 will first travel a distance S4 and thereafter come into engagement with the fixed stop 64. The movable stop 65 is thereby so located that the length S4 will be very short, which means that the transmission bar 58 and thereby also the arresting means 54, the four-way valve 45 and the three-way valve 47 will remain in an unaltered position, practically speaking. For further manual tipping of the bucket 9, the cable end 19^1 will be blocked, whereas the part of the cable 19 which is attached via the cable pulley 17 can still be wound up onto it during continued manual tipping of the bucket 9. Because the valves 75 and 77 take up positions for giving parallel motion to the bucket, as is menttioned above, the previously set parallel motion will automatically operate on subsequent lowering of the lifting arm 2, and the bucket will automatically be brought into a parallel attitude without the manual re-setting movement of the bucket being necessary after tipping. If thus the arresting means 54 has once been set for a certain control of the bucket parallel motion it does not need to be altered at extreme end positions of the lifting arm during tipping operations of the bucket.

The alternative device to the tension spring 59 according to Figure 7 comprises a drum 67, mounted for rotation on a shaft 66 rigidly attached to the chassis 3, and a cable or steel band 68 attached to the drum. The drum 67 coacts with a torsion type spring means (not shown) which strives all the time to turn the drum in the direction denoted by the arrow P18. The cable 68 is attached to the lower end of the transmission bar 58 in a way clearly shown in Figure 7, pulling the transmission bar 58 in a downward direction in the figure by means of the turning force from the drum 67, working thus analogously to the tension spring 59 in Figure 2.

Amongst other things, this solution has the advantage of giving smoother pulling force within the whole displacement range of the transmission bar 58.

Figure 8 shows in section an alternative embodiment of the four-way slide valve 45, the three-way valve 47 and the intermediate means 53, in which the said means are built together in one unit. A slide 70 runs in a slide housing 69, these two being provided with grooves and recesses in a manner known *per se* for providing the previously described function. In Figure 8 there is thus shown a position corresponding to the operational state according to, Figure 3, dashed lines denoting fluid flow through the lines 37, 38 and 36, 39, respectively while the connections for the lines 42, 43, 44 are denoted with corresponding reference numerals.

In a lower portion of the slide 70 in Figure 8, there is arranged an intermediate means comprising a tubular inner spring washer 71 and a corresponding outer spring washer 72 with an intermediately located compression spring 73. By means of centre holes 74 the spring washers 71, 72 are axially displaceable on a screw or pin 75 centrally fixed to the slide 70. In an intermediate position the inner spring washer washer 71 abuts against the slide housing 61 while the outer spring washer 72 abuts against the inner bottom surface of a cover 76 attached to the slide housing 69. It will be appreciated from Figure 8 that every movement of the slide 70 according to the double arrow P19 causes compression of the compression spring 73, signifying that the slide 70 will be affected by a re-setting force for every deviation from the intermediate position. In other words, the device has the same effect as the intermediate means 53 but has the practical advantage that in combination with the combined valves 45, 47 forms a compact and easily fittable unit.

The described parallel motion system has been found to function extremely well in practical trials. Its great advantages lie in simple components and extensive operational possibilities. The advantage of being able to quickly and simply cut out or couple in parallel motion is obvious, as well as the possibility of quickly being able to angularly position the bucket 9 to an altered attitude of parallel motion.

There are great possibilities within the scope of the invention as defined by the appended claims to vary the design of the components which regulate the parallel motion. Thus, the cable 19 can be replaced by a Bowden cable or a lever mechanism. Furthermore, the arresting means 54 can be so arranged that it co-acts by friction with the transmission bar 58. The locking pin 55 can be replaced by a bifurcated engaging means co-acting with a cylindrical portion of the transmission bar 58, end portions on it having less diameter than the cylindrical portion for preventing arresting at the previously described extreme positions of the bucket 9.

WHAT I CLAIM IS:—

1. A parallel motion arrangement for controlling the attitude of a bucket or the like mounted on a lifting arm in a mechanical excavator, power shovel or similar machine, comprising means for sensing the angular attitude of the bucket relative to the lifting arm, actuator means for altering the attitude of the bucket relative to the lifting arm, and control means operated by said sensing means for controlling the actuator means to successively alter the angular attitude of the bucket in response to the lifting position of the lifting arm, transmission

means coupled to the sensing means and arresting means associated with the control means for optional co-action with said transmission means in relative mutual positions for operating the control means to control the bucket so that it automatically retains a predetermined angular attitude in relation to a ground configuration, the control means comprising a slide valve which on being operated by means of the co-action of the arresting means with the transmission means directs fluid to the actuator means for regulating the angular attitude of the bucket, and said slide valve being mechanically linked with a three-way valve whereby at extreme operation of said valves the three-way valve is caused to re-direct the fluid flow so that fluid from the outlet side of a working cylinder for operating the lifting arm is transferred as additional fluid to the actuator means for th bucket for its re-adjustment during rapid lowering of the lifting arm.

2. An arrangement as claimed in Claim 1, wherein the transmission means consists of a transmission bar having a toothed portion and the arresting means comprises a locking pin having a tapering portion which is settable to coact with the toothed portion of the transmission bar, the pin being settable electrically or mechanically by means of a Bowden cable or the like on depression of a push-button.

3. An arrangement as claimed in Claim 2, wherein the toothed portion on the transmission bar has a predetermined length and extends between non-toothed end portions of the transmission bar which end portions prevent coaction between the bar and the arresting means in critical end positions in the angular attitude between the lifting arm and bucket.

4. An arrangement as claimed in any one of the preceding claims, further comprising an intermediate position means arranged on the arresting means, slide valve and three-way valve.

5. An arrangement as claimed in Claim 2, wherein the sensing means comprises a cable which is attached to a first cable pulley that moves angularly with the bucket, and the cable runs over a second cable pulley of the same diameter as the first cable pulley, the second cable pulley is arranged on the pivots for the lifting arm and the cable is connected to the transmission means, and means are provided to keep the cable permanently tensioned.

6. An arrangement as claimed in Claim 5, wherein the cable is fitted with expandable means, and on a portion of the cable which is connected to the transmission means there is provided a first stop adjustable as to its position and between this stop and an opposing end of the expandable means there is a second stop connectable to the lifting arm so that in a predetermined position of the lifting arm in respect to the bucket both the stops abut each other, whereby the pulling movement of the cable on the transmission means is stopped and further pulling movement is taken up by expansion of the expandable means.

7. A parallel motion arrangement for controlling the attitude of a bucket or the like mounted on a lifting arm in a mechanical excavator, power shovel or similar machine, substantially as hereinbefore described with reference to the accompanying drawings.

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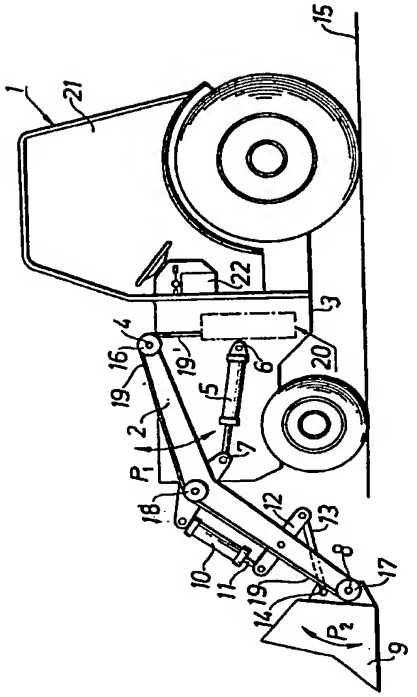

Fig.1

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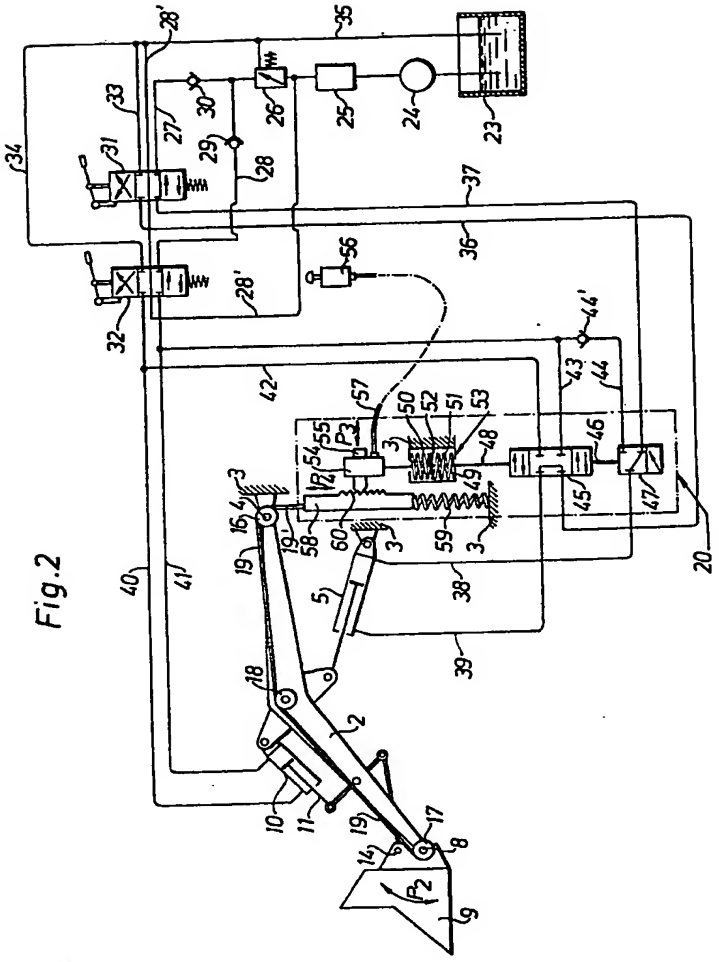

Fig.2

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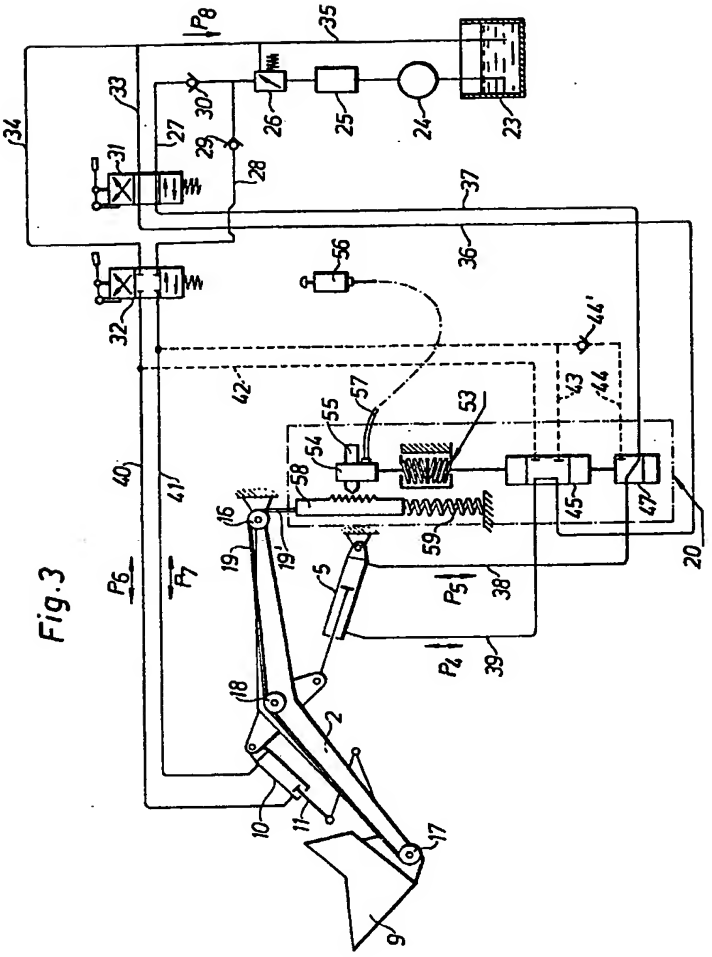

Fig.3

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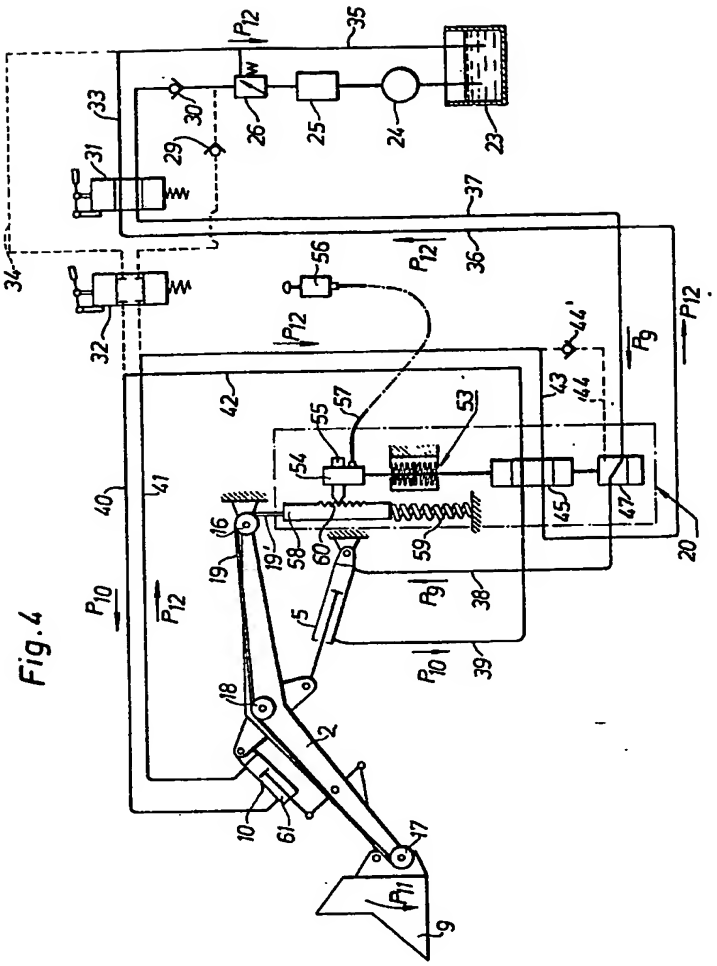

Fig. 4

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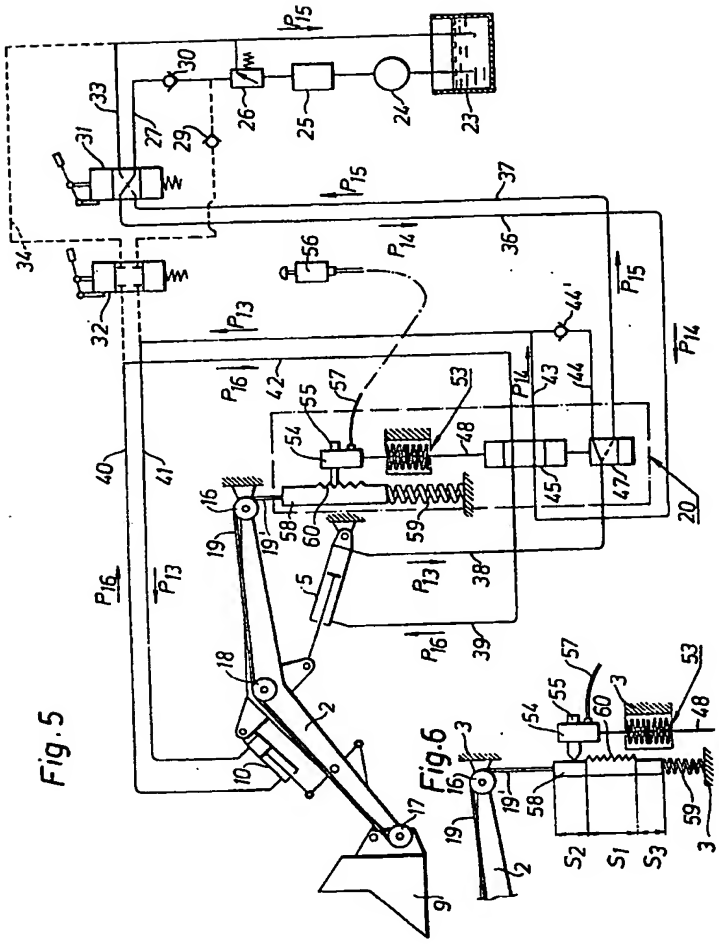

Fig.5

Fig.6

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Sheet 6

Fig. 7

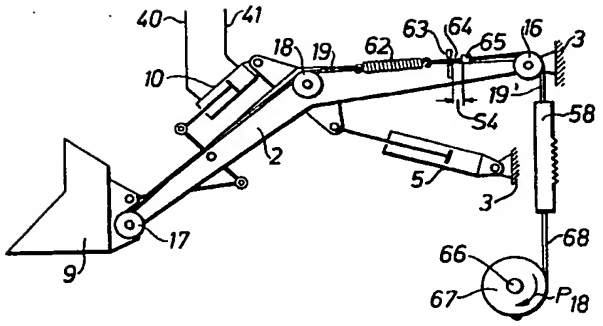

Fig. 8